Crosswell Seismic in Three Dimensions

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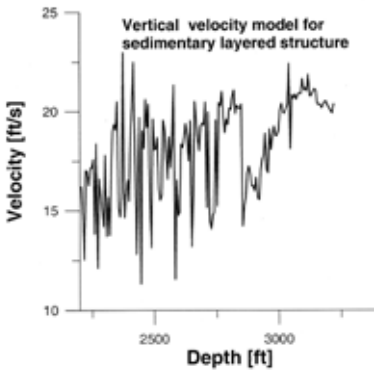
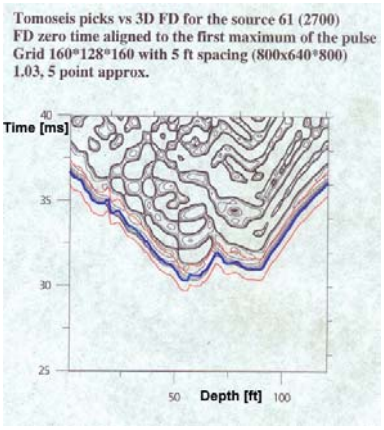
Research Objectives

Recent advances in data acquisition, including shooting "on-the-fly", multilevel receiver systems, higher telemetry rates, and stronger sources have dramatically decreased survey costs, opening up the potential for multiwell, 3-D surveys over large areas of existing reservoirs. Until recently, most crosswell surveys have been performed on a single vertical well pair creating a very limited 2-D cross sections between the wells. Most of the imaging algorithms currently in use were developed under the assumption of near well trajectories with minimal out of the plane dip. In real world geometries 3-D effects must be incorporated. By performing multywell surveys, 3-D coverage over sections of the reservoir is achieved. Extending crosswell imaging technology to handle the three dimensional nature of wells and earth models is the ultimate objective of this work.

Approach

The extension from a single well pair to a 3-D well and survey geometry has revealed imaging issues that were not adressed in the initial development of the crosswell technology. Recently Tomoseis Inc. have developed a common earth model framework using a Chebychev polynomial representation for performing cross well imaging. They have also developed visualization approaches to 3-D well and survey geometries. The general work plan involves the development and testing of 3-D traveltime inversions, 3-D reflection mapping and 3-D migration. The product of this work will be a series of algorithms and software that will be capable of performing cross well imaging and visualization in real world, 3-D, multi-profile crosswell data. The specific work plan for LBNL involves the development of algorithms and computer programs for 3-D simulation of elastic wave propagation.
LBNL's participation in SBIR project jointly with Tomoseis Inc.consists of developing of efficient computer codes to simulate 3D crosswell seismic data sets and computing of those data sets for variety of models. To provide a reliable good quality of data sets the first stage of code developing will include intensive testing and verification for variety of models. Figures below show very good accuracy of first arrivals compare to ray method solution (blue) computed for complex layered structure. The discrepancies are well inside of the 2% error corridor (red).





The development of practical 3-D crosswell imaging will take crosswell technology from a limited market to widespread use by geoscientists and reservoir engineers. The use of the technology will greatly improve production of oil and gas from domestic reservoirs, increasing reserves, enhancing recovery, and lowering development and production costs.

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